CS534 - MACHINE LEARNING

FINAL EXAM

Author: Vy Bui
Email: buivy@oregonstate.edu

The School of Electrical Engineering and Computer Science
Oregon State University

Contents

Chapter 1

DECISION TREE

1.1 Mutual Information

Entropy

$$H(X) = -\sum_{k=1}^{K} p(X=k) log_2 p(X=k) \tag{1.1}$$

Entropy for Binary Random Variable

$$H(X) = -p(X=1) log_2 p(X=1) - p(X=0) log_2 p(X=0) \tag{1.2}$$

Joint Entropy

$$H(X,Y) = -\sum_{x,y} p(x,y) log_2 p(x,y) \tag{1.3}$$

Conditional Entropy

$$H(Y|X) = H(X,Y) - H(X) = -\sum_{x,y} p(x,y) log_2 p(x,y) - \sum_{x} p(x) log_2 \frac{1}{p(x)} \tag{1.4}$$

or more general

$$H((X_1, X_2, ..., X_n)) = \sum_{i=1}^{n} H(X_i|X_1, ..., X_{i-1}) \tag{1.5}$$

(1.4)
Mutual information tells us how similar two distributions are.

$$I(X,Y) = H(X) - H(X|Y) = H(Y) - H(Y|X) \tag{1.6}$$

[Mur22], 6.3

Notes from [Mur22], 18

- Multi-way split might cause **data fragmentation** (too little data might fall into each subtree), resulting in overfitting.
-
-

[HTF17], 9.2

Chapter 2

Emsemble Methods

Weak and Strong learners?

2.1 Bagging

refer to [Mur22], chapter 18.3 Bagging.

2.2 Boosting

[Bis06], 14.3

Chapter 3

Clustering

3.1 Hierarchical Clustering

For **Hierarchical Clustering**, refer to [Mur22], chapter 21.2 Hierarchical clustering.

For **Flat Clustering**, refer to [Mur22], chapter 21.3 K Means Clustering.

3.2 K-means

3.2.1 Limits

- restrictive assumption that all clusters have the same sperical shape
- assumes that all clusters can be described by Gaussians in the input space, so it cannot be applied to discrete data

Chapter 4

Mixture of Gaussians

4.1 Maximum Likelihood

4.2 Expectation Maximization (EM)

4.2.1 Optimization Transfer

4.2.2 Properties

Chapter 5

Model Selection and Evaluation for Clustering

Bibliography

[Bis06] Christopher M. Bishop. *Pattern Recognition and Machine Learning*. Springer, 2006.

[HTF17] Trevor Hastie, Robert Tibshirani, and Jerome Friedman. *The Elements of Statistical Learning*. Springer, 2017.

[Mur22] Kevin Patrick Murphy. *Probabilistic Machine Learning, An Introduction*. The MIT Press, 2022.